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RADIATION DISCRIMINATORS: AN ANNOTATED BIBLIOGRAPHY

SPECIAL BIBLIOGRAPHY
SB-62-34

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Compiled by
CHARLIE M. PIERCE

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Lockheed

MISSILES & SPACE COMPANY

A GROUP DIVISION OF LOCKHEED AIRCRAFT CORPORATION

SUNNYVALE, CALIFORNIA

ABSTRACT

The scope of this search involves instrumentation and circuitry which have been designed to discriminate between the various types of nuclear radiations. A majority of the selected references describe techniques for measuring the intensity of a particular type of radiation in a mixed radiation field.

References are arranged by author.

Search completed August 1962.

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This selective bibliography has been prepared in response to a specific request and is confined to the limits of that request. No claim is made that this is an exhaustive or critical compilation. The inclusion of any reference to material is not to be construed as an endorsement of the information contained in that material.

1. Aichroth, J. W., Sleven, R. L. and Speh, K. C.

FURTHER DEVELOPMENT OF MICROWAVE GAMMA-RAY ION CHAMBER. Airborne Instruments Lab. Div. of Cutler-Hammer, Inc., Deer Park, N. Y.

Jul 1961. 44p. ASD-TR-61-32.

A microwave gamma-ray ion chamber has been developed that measures gamma radiation from 10^6 to 10^{10} ergs per gram-hour (carbon in the presence of a neutron flux of 10^{10} neutrons per square cm per second.) The choice of materials, development of a unique vacuum system, and fabrication of chambers suitable for operation to 500 °C in a high neutron flux are discussed. Data are presented on the response of an ion chamber to various ratios of incident gamma, thermal neutron, and fast neutron fluxes.

2. Amato, C. G. and Malsky, S. J.

Radiophotoluminescent gamma-ray dosimetry of mixed neutron gamma-ray radiation fields.

RADIOLOGY. v. 76, p. 290 – 1. Feb 1961.

A procedure is described for the convenient measurement of γ dose in a neutron-γ field. An unshielded radiophotoluminescent glass needle is used. The energy absorption due to neutron activation is calculated and this value is subtracted from the gross needle reading to give the γ dose delivered to the needle.

3. Bedo, D. E. and Tomboulian, D. H.

Photon-counting spectrometer for attenuation measurements in the soft X-ray region. REV. SCI. INSTR. v. 32, p. 164 – 8. Feb 1961.

A grazing incidence spectrograph, originally designed for photographic registration, was modified for the purpose of making attenuation measurements at selected wavelengths in the 100 to 300 A region. The modifications over previous procedures include: the introduction of an open multistage copper-beryllium electron multiplier for the purpose of comparing intensities by counting photons and the use of the characteristic valence emission bands of the light metals as sources of incident radiation. The photomultiplier was mounted on an arm attached to a spindle whose

3. (cont'd) axis was normal to the base plate and passed through the Rowland circle at the selected wavelength. Defining slits, placed between the grating and entrance window of photomultiplier, limited the spectral band used in irradiating the absorbers. The latter were placed in the diffracted beam at the position of "least confusion" and could be rotated independently about the common vertical axis of the spindle, thus varying the angle at which the incident beam strikes the surface of the sample. Various tests indicated that the source intensity and detector sensitivity are adequate for the attainment of satisfactory counting rates. In conjunction with the particular sources referred to, the photon-counting scheme makes it possible to improve materially the precision of existing attenuation measurements.

4. Bernard, C. H., Thornton, W. T. and Auxier, J. A.

Silver metaphosphate glass for X-ray measurements

in coexistent neutron and γ-radiation fields.

HEALTH PHYS., v. 4, p. 236 – 43. 1961.

Small glass rods, 1 mm in diameter by 6 mm long, composed of the metaphosphates of Al, Ba, K, and Ag, were exposed to both neutrons and γ radiation to determine their suitability as γ dosimeters in mixed fields. Filters in the form of cylindrical capsules were constructed to eliminate the major portion of the increased response per unit of exposure dose in the photoelectric region. The fast neutron response was determined in the energy range of 0.5 to 1.5 Mev; the maximum response in this range of energies was 0.7% of that of Co^{60} γ radiation in units of tissue rad. Thermal neutron exposures were made in the ORNL graphite reactor thermal column; flux measurements were made with Au and Au+Cd foils. A response equivalent to an exposure dose of 1 r of Co^{60} γ rays was induced by $(2.96 \pm 0.39) \times 10^9$ n_t/cm^2. Preliminary measurements with similar rods in which the elements Ba and K had been replaced by Mg and Li, respectively, indicate a lower peak γ response per unit of exposure dose in the photoelectric region and an increased sensitivity to thermal neutrons; 1 r equivalent response was produced by $(3.7 \pm 0.4) \times 10^8$ n_t/cm^2.

5. Biggerstaff, J. A., Becker, R. L. and McEllistrem, M. T.

Charged particle discrimination in a CsI(Tl)

detector. NUCLEAR INSTR. & METHODS.

v. 10, p. 327 – 32. Apr 1961.

Two techniques requiring measurement of short time intervals are reported. A charged reaction product discrimination method is developed that depends upon the fact that different types of charged particles of approximately the same energy yield significantly different fluorescent decay times in a CsI(Tl) scintillator. Tests are

5. (cont'd) conducted on the reaction products of the Be^9 + d reactions and on the protons from the $C^{12}(d, p)C^{13}$ reaction. Using relative decay time measurements, alpha-particles are clearly separated from protons or tritons. Protons and tritons are clearly separated from one another as long as the triton energy does not exceed the proton energy by as much as twenty percent.

6. Bonyushkin, E. K. and Spektor, V. V.

Scintillation spectrometer with channel control. PRIBORY I TEKH. EKSPT. n. 6, p. 30 – 4. Nov – Dec 1960. (In Russian)

Descriptions are given of a luminescence γ spectrometer with a CsI(T1) crystal and channel control. The spectrometer is capable of dividing close lines in a complex spectrum and separating weak activity in a strong background. The resolving power is 12.5% for E_γ = 0.663 Mev and 10.5% for E_γ = 1.33 Mev. The efficiency at E_γ = 0.663 Mev is W = 1.3%.

7. Bormann, M. et al.

Particle discrimination with scintillation counters. NUKLEONIK. v. 3, p. 85 – 92. May 1961. (In German)

Recent investigations on a series of scintillation crystals have shown that in many scintillators differences in the decay time of scintillations occur according to the particle (α particles, protons, or electrons) which releases the scintillation. In many cases the differences are so considerable that the scintillation pulses can be sorted according to their origin. Information is given on the present state of the investigations on these phenomena. The methods used for practical application in the field of nuclear physical measurement techniques are discussed. Twenty-five references.

8. Bovin, V. P.

Methods of directional recording for gamma rays. ATOMNAYA ENERG. v. 9, p. 483 – 7. Dec. 1960. (In Russian)

8. (cont'd) The basic characteristics and parameters of a directional radiation receiver are analyzed. Scintillation radiometers of the directional compensation type are studied and their advantages over similar gas discharge counters are stressed. Description are given of various compensation systems for detecting and measuring radioactive elements.

9. Bozoky L.

THE METHODS AND PROBLEMS OF

MODERN DOSIMETRY. (Translation of

FIZ. SZEMLE v. 11 n. 5 p. 135 – 41.

May 1961. 4p.) JPRS-10581

Requirements for dosimeters are summarized, such as directional insensitivity, energy independence, distinction between various types of radiations, calibration characteristics, time constants, saturation properties, and durability. The use of ionization chambers as dosimeters is discussed. It is noted that no satisfactory dosimeters exist for photons above 3 Mev, medium energy neutrons, or doses from impulse devices.

10. Brooks, F. D.

IMPROVEMENTS IN OR RELATING TO

NUCLEAR PARTICLE DISCRIMINATORS. British

Patent 862,331. 8 Mar 1961.

A circuit is described for discriminating between types of particles detected by scintillation counters based on different decay times of the scintillations. In the circuit, one form of that claimed in British Patent 823, 263, two pulses are derived from a photomultiplier tube, the pulse amplitudes being proportional to the area and amplitude of the scintillation pulse, respectively, and a difference pulse in turn is derived from these pulses and applied to a pulse amplitude discriminator. The electrodes for producing the pulses are the anode and a dynode, and the deriving means are such that the pulses are of opposite polarity. A connection including a resistor is made between each deriving means and a common output resistor across which the difference pulse is developed.

11. Brooks, F. D.

A scintillation counter with neutron and gamma-ray discriminators. NUCLEAR INSTR. & METHODS. v. 4, p. 151 – 63. Apr 1959.

Certain organic scintillators, notably anthracene, stilbene and quarterphenyl crystals and oxygen-free liquid scintillators, show an effectively longer scintillation decay time for heavily ionizing particles such as alpha-particles or protons than for electrons. A scintillation counter is described which distinguishes fast neutrons from gamma-rays by means of the different decay times of recoil proton and Compton electron scintillations, respectively. Measurements of the proton-electron resolution for different scintillators are described. It is found, for example, that using a one-inch thick stilbene crystal, 2 Mev neutrons may be detected with 9.5% efficiency while the detection efficiency for 2 Mev gamma-rays is reduced by decay time discrimination to less than 0.007%. An application of the counter for fission cross section measurements by fission neutron detection is described. The decay time properties of the scintillators are discussed and the longer decay time for protons (or alpha-particles) is interpreted in terms of slo (10^7 sec) ion recombination processes in the scintillators; these processes produce a slow component in the scintillation decay and in a proton scintillation the proportion of slow component is more than in an electron scintillation.

12. Burrus, W. R.

Nonlinear methods in spectrum unscrambling. In TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY, PROCEEDINGS OF THE SYMPOSIUM. Gatlinburg, Tennessee, 10–11 May 1960. p. 159–67. TID-7594.

Some attempts to correct for instrumental smearing by analytical means give wildly fluctuating results for the desired incident spectrum. These suprious fluctuations are known to be due to an amplification of the inherent statistical errors in the experimental data. Since these methods produce nonphysical negative values for the calculated incident spectrum at some energies, it is reasonable to hope that the addition of a restriction which requires the calculated spectrum to be entirely positive would give "better" results in some sense. Some interim results of an investigation on the use of linear programming and quadratic programming to restrict the solution to positive values are presented.

13. Caldwell, D. O. and Janes, G. S.
Beam monitoring methods; Part I: Monitoring High-Energy Proton Beams – Part II: Monitoring High-Energy Electron and X-ray Beams. In TECHNIQUES OF HIGH ENERGY PHISICS, Ritson, David M. (ed), New York, Interscience Publishers. 1961. p. 487–520.

Monitoring methods for proton, electron and x-ray beams are described. Both relative and absolute proton monitoring devices are studied. In monitoring energetic electrons or x-rays, bremsstrahlung and pair production caused by interactions with nuclear Coulomb fields must be included in the total effect. Methods for determining electron and x-ray beam spectra are given.

14. Cambou, F., Crettez, J. P. and Ambrosino, G.
Discrimination of shapes with a mineral scintillator (CsI). Application to the tracing of spectra or of proton spectra in the presence of rays. COMPT. REND. v. 251, p. 2681–3. 5 Dec 1960. (In French)

The shape of the scintillation produced by ionizing particles in cesium idodide is different for protons, α particles, and electrons. A circuit extracting part of this difference permits the suppression of the γ background when the spectrum of α particles or protons is measured. The spectrum of recoil protons from 3-Mev neutrons is shown.

15. Crawford, G. W.
Cosmic Radiation Measurement Problems. In SEMICONDUCTOR NUCLEAR PARTICLE DETECTORS. J. W. T. Dobbs and F. J. Walters, ed. Washington, 1961. p. 57–60. NAS-NRC-Pub-871.

15. (cont'd) The composition of the inner and outer cosmic radiation belts is surveyed, and the advantages of solid state ionization chambers for their detection and measurement are discussed. Possible telescopes for energy band measurements are described. The radiation to be measured can be selected by changing the bias voltage. The application of solid state detectors in biological radiation damage studies is also considered.

16. DuMond, J. W. M. and Seppi, E. J.

Nuclear gamma-ray spectroscopy by crystal diffraction. HILGER J. v. 6, p. 48–55. Jun 1961.

The transmission-type bent-crystal focusing spectrometer is described. The ideal perfectly focusing solution and the approximate solution of Cauchois are given. Methods are discussed, and schematics are given. A list of spectrometers using these principles is presented, and design and performance of some of these are discussed.

17. Eckardt, A and Burger, E.

Simple measurement methods for the determination of bremsstrahlung total energies in the presence of strong electromagnetic perturbation fields. EXPTL. TECH. PHYSIK, v. 8, p. 210–16. 1960. (In German)

Total energy determinations can be made by a systematic decrease of the electron expenditure when the usual electronic auxiliaries are no longer dependable because of the electromagnetic perturbation effects. The measurement accuracy of this method is sufficient for average requirements.

18. Edwards, W. F., Dumond, J. W. M., and Boehm, F.

An intensity calibration of the two metre curved-crystal spectrometer. NUCLEAR PHYS. v. 26, p. 670–80. 1961.

18. (cont'd) The 2-m curved-crystal diffraction spectrometer at the California Institute of Technology was calibrated to permit precise relative intensity measurements of gamma rays or X-rays over the energy range 60 to 400 kev. The curved quartz crystal (2 mm thick, (310) planes) was found to have a dependence of relectivity I/I_μ upon energy E given by $I/I_\mu = (E_0/E)^{1.987 \pm 0.022}$, where E_0 is a reference energy within the range of the calibration. The relative intensity uncertainty, from sources other than counting rare statistics, is now of the order of 3% of less for gamma rays differing in energy up to a factor of four.

19. Egorov, Yu. A. and Pankratev, Yu. V.

A fast neutron spectromer with one data unit.

INZHENER.-FIZ. SHUR., AKAD. NAUK BELORUS.

S. S. R. v. 4, n. 6, 112–15. Jun 1961. (In Russian)

A crystal of stilbene irradiated by neutrons and γ rays creates pulses of different forms, so that pulses of neutrons can be distinguished on a background of pulses of γ rays. Using this fact, a fast neutron scintillation spectrometer is made which is not sensitive to a γ background when irradiated by neutrons with an energy of $E_n > 2$ Mev. The spectrum of the source Po + Be is measured.

20. Ehrlich, M. and McLaughlin, W. L.

Photographic response to successive exposures of

different types of radiation. J. OPT. SOC. AM.

v. 51, p. 1172–81. Nov 1961.

Given the photographic response curves characteristic for any two types of radiation, it is possible to predict the course of the density-versus-exposure curves produced by the two types of radiation in succession, and thus, tentatively, to draw conclusions as to the behavior of the latent image. The results of successive exposures to x and gamma radiation of different photon energy and intensity, to gamma radiation and visible light, and to visible light and infrared radiation show that – after some initial transition phenomena – the shape of the density-versus-exposure curve is essentially the same as that of the curve corresponding to the second type of exposure, administered alone. In the region of transition, changes in the curve shape may occur which suggest transformations of the latent image, leading to photographic sensitization, desensitization, or reversal. Some of the double-exposure effects found in the literature are discussed in relation to the data presented here.

21. Elleman, T. S., Howes, J. E., Jr., and Sunderman, D. N.

A technique for the resolution of complex gamma

spectra using a single-channel gamma-ray spectrometer.

INTERN. J. APPL. RADIATION AND ISOTOPES.

v. 12, p. 142–4. Dec 1961.

The technique described is simple, applicable to a single-channel gamma spectrometer, relatively insensitive to spectrometer drift, and suitable for the resolution of a wide variety of gamma emitting isotopes. The technique is described in terms of the resolution of the complex spectrum for the Cs^{134}-Cs^{137} mixture. By obtaining counting rates for an unknown Cs^{134}-Cs^{137} mixture at two spectrom

Such measurements may also be carried out by measuring the change in the electrical conductivity of semiconductors exposed to fast neutrons; this is based on the fact that the concentration of lattice defects which determine the conductivity is proportional to the integrated fast neutron flux. As sensing elements n-type Ge specimens in a 0.5-mm thick Cd cladding were used. The conductivity was followed by determining the changes in the current applied under constant voltage to the specimens during the irradiation. The relative distribution of the fast neutron flux in one of the vertical beam holes in the reflector of the reactor located in the A. R. Ioofe Physical-Technical Institute was determined by this method.

22. Evseev, V. S. et al.

LAMINATED SCINTILLATION DETECTOR

FOR THE REGISTRATION OF FAST NEUTRONS IN

THE PRESENCE OF γ-QUANTA (Translation of

USSR report JINR-P-470. 1960. 23p.) UCRL-Trans-664 (L)

A laminated detector which is highly efficient in registering neutrons and is insensitive to gamma radiation is described. The detector, intended for registration of neutrons in the energy interval from 5 to 20 Mev, consists of 28 disks of a plastic scintillator, 80 mm. in diameter and 4 mm. thick. Adjoining disks were separated from each other with black paper. There was no optical contact of the paper with the disks. The electronics and basic characteristics of the detector are discussed.

23. Fenyes, T.

Semiconductor nuclear spectrometers.

KOZLEMENYEK. v. 3, p. 43-54. 1961.

(In Hungarian)

After a historical review of α - radiation detectors using semiconductors such as the half-n, half-p type semiconducting Ge based on the establishment of a voltage difference resulting from the diffusion of the voids, the physical principles of the detection mechanism and the characteristics of the detectors built are discussed. Recently the energy of β - particles up to 100 to 150 kev was successfully determined by means of p-type semiconductors with high specific resistivity. Progress was made in the measurement of the energy of γ - photons but the currently available instruments are in general not sensitive to individual photons. The semiconducting device is comparable to an ionization chamber operating on the electron collection principle but it presents the advantage of not requiring high voltage; its construction is simplified by the fact that the gas purification train is omitted. The energy discrimination is better but the detecting surface is smaller than that of the ionization chambers. It is well suited for determination of fission products, $\alpha - \gamma$ coincidence measurements, and for the study of the fine structure.

24. Francis, J. E., Jr., Harris, C. C. and Bell, P. R.

A focusing collimator for research in scanning.

J. NUCLEAR MED., v. 3, p. 10-17. Jan 1962.

A description is given of the latest directional gamma detector developed at Oak Ridge National Laboratory. Gamma rays are detected by a 3-inch diameter by 2-inch thick NaI(T1) crystal integrally mounted on a 3-inch phototube. The crystal is housed in a massive tungsten alloy shield, two inches thick at the sides and 3 inches from its front face. Because of the use of tungsten and gold, the assembly is more expensive than lead collimating shields. However, it is believed that the increased expense may be justified by the unremarkably improved performance. In particular, the improved shielding of the new detector appears to have alleviated some of the problems in outlining the liver.

25. Fuse, T.

DISCRIMINATION OF NEUTRONS FROM GAMMA

RAYS IN THE SCINTILLATION COUNTER. Japan

Atomic Energy Research Inst., Tokyo. Report No.

15. 1961. 7p. (JAERI-1015) (In Japanese)

25. (cont'd) Research related to the optimum conditions for the discrimination of neutrons from gamma rays is reported. Several types of photomultipliers were used and the degree of discrimination was found to depend on the type of photomultiplier. A clue for the mechanism of the scintillation in anthracene is also suggested, that is, there may be a little difference between the spectra of fast and slow components of the light of scintillation, both of which are distributed around 4,000 A.

26. Harris, C. C. et al.

An oscilloscope monitor for scintillation spectrometers. J. NUCLEAR MED., v. 1, p. 280–4. Oct 1960.

Gamma-ray counting with single-channel scintillation spectrometers is an established and useful tool in nuclear medicine. However, beginning users of spectrometers are often confused by the apparent complexity of the instruments. Even operators with some experience are sometimes disturbed by misbehavior of the instruments, whether the misbehavior is major, minor, or simple misadjustment. An auxiliary device has been developed which eliminates guesswork in adjusting a spectrometer to count a certain region of a γ-ray spectrum. This device will also enable an operator to quickly determine whether apparent instrument failure is real or a result of misadjustment. This oscilloscope monitor is simple but effective.

27. Heath, R. L.

Data processing techniques for routine application of gamma-ray scintillation spectometry. In TOTAL ABSORPTION GAMMA–RAY SPECTOMETRY, PROCEEDINGS OF THE SYMPOSIUM. Gatlinburg, Tennessee, 10–11 May 1960. pp. 1-47. TID-7594

A program to reduce the techniques of quantitative gamma-ray scintillation spectrometry to routine laboratory practice has been in progress at this laboratory for several years. Recent investigations were directed to the improvement and extension of the gamma-ray spectrum catalogue originally compiled for the 3 × 3 in. NaI detector. The detector response to monoenergetic gamma sources and bremsstrahlung was studied in detail, with particular attention given to the effects of equipment stability, detector resolution, scattering geometry, and absorbing material introduced to attenuate unwanted radiation. The results of these studies are presented along with

27. (cont'd) computer techniques developed for generating pulse-height distributions and quantitative analysis of data. An automatic data handling system for multichannel pulse-height analyzers is described which permits direct quantitative analysis of complex spectra in the analyzer memory through the use of auxiliary equipment with fast read-out and re-entry on perforated paper tape. An extended revision of the gamma-ray spectrum catalogue, containing over 250 spectra of nuclides and gross fission products, is presently being compiled in digital form on perforated tape. The application of these data is discussed in detail.

28. Huber, O., Schellenberg, L., and Wild, H.
First measurements with a new type high
resolution spectometer. HELV. PHYS. ACTA.,
v. 33, p. 534–40. 1960. (In German)

The construction of a spectrometer with the field configuration $H = H_0(1-\alpha e + \beta e^2 - \gamma e^3)$ for $\alpha = 1/2$, $\beta = 3/8$, and $\gamma = 43/144$ and the ability to take measurements with film and to record energy range simultaneously is described. The field configuration was independent of the hysteresis of the iron, and the pole distance could be made very large in comparison to the magnet diameters. The first calibration measurements, which were made to determine the behavior of the iron, the controllability of the field, the focusing properties, and the resolution are reported.

29. Husain, T.
Single crystal gamma-ray scintillation spectrometer.
J. NAT. SCIENCES AND MATH., v. 1, p. 1–15.
Apr 1961.

A single crystal gamma-ray scintillation spectrometer is described. A technique for polishing and mounting the NaI(Tl) crystal is used that improves the resolution.

30. Husain, T.
Three crystal gamma-ray scintillation pair
spectrometer. J. NAT. SCIENCES AND MATH.,
v. 1. p. 16–33. Apr 1961.

A scintillation pair spectrometer is described. In order to improve the resolution differential discriminators are incorporated in each side channel of the spectrometer.

31. Hutchinson, G. W.

Highly directional detector for cosmic ray particles. NUOVO CIMENTO. v. 11, p. 377–81. 1 Feb 1959. (In English)

A relatively simple Cherenkov detector is described which will respond to relativistic charged particles only when their directions lie within a well-defined cone. The limits of the cone are determined by the critical reflection of Cherenkov light from parallel faces of the radiator. The semiangle of the cone may be chosen at will be varying the refractive indices used. It is suggested that the detector might be useful for attempts to detect a directional flux of uncharged primary particles at high altitudes.

32. Jahoda, F. C.

Soft x-ray spectroscopy of a hot plasma IRE TRANS. ON NUCLEAR SCI., NS-8. n. 4, p. 81–2. Oct 1961.

A single crystal x-ray spectrometer was constructed and applied to the study of the x-ray spectrum. The initial measurements of the soft x-ray continuum were made by studying the relative attenuation of several different types and thicknesses of absorber foils. The diffracting element is a beryl crystal of lattice spacing 7.97 A, permitting measurements of the emission spectrum between 5 and 15 A. The energy resolution of the spectrometer over most of its range is determined by the diffraction pattern of the crystal and is 1000 at 10 A. The plastic scintillator photo-multiplier detector gives a time resolved record of the emission intensity during the 0.8 sec emission interval. The one electron hydrogen-like spectrum of seven times ionized oxygen (O VIII) and the two electron helium-like spectra of Na X, Mg XI, and Al XII are well developed and easily resolved.

33. Knowles, J. W.

γ-ray energy determinations. In PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON NUCLIDIC MASSES, Duckworth, H. E. (ed), Toronto, Canada, University of Toronto Press. 1960, p. 360–365.

33. (cont'd) Methods for γ-ray measurements are discussed with respect to determination of nuclear reaction energies. The following instruments are reviewed: (1) γ-ray spectometers (a) with low resolution and high efficiency and (b) with high resolution and low efficiency. (2) Spectrometers using coherent scattering (a) with curved crystal and (b) with double flat crystal. The neutron capture γ spectrum of Gd^{156} is given. Neutron capture γ rays in the reaction $H^1(n, \gamma)H^2$ were used to determine the deuteron binding energy, which was found to be 2227.0 ± 0.6 kev.

34. Koch, L. Messier, J., and Valin, J.

Description of NIP junctions utilized as detectors of nuclear particles. Spectrometry of high energy ionizing particles. Detection of γ rays.

COMPT. REND, v. 251, p. 2912–14. 19 Dec 1960.

(In French)

The properties of silicon NIP junctions permit the utilization range of semiconductor radiation detectors to be extended to high energies. In a first stage it was possible to measure the energy of 40-Mev α particles with an energy resolution of 2%. With these junctions γ rays were detected and a photoelectric peak was found.

35. Lagasse, A.

Radiation measuring principles. Part 2.

REV. M. B. L. E. v. 3, p. 237–61.

Dec 1960. (In French)

The description of instruments transforming radiations into electrical pulses is continued. The operation principle of the first scintillation counter, the spinthariscope, and the progress that the use of photomultiplier cells has permitted in radiation detection with scintillators are reviewed. Some characteristics in the construction of scintillators are examined, and the phenomenology, efficiency, and background noise of the scintillation probe are studied. The diagrams of scintillation spectrometry in corpuscular radiations and gamma rays are analyzed. The usc of a spectrometer permits the selective recording of a radiation with well-defined energy. The Cherenkov counter is discussed. The nature of the luminescent phenomenon involved is indicated, and it is shown how the Cherenkov effect can be utilized to detect fast particles. The operational principles of semiconductor counters are also briefly reviewed.

36. Lockheed Aircraft Corp., Sunnyvale, Calif., FEASIBILITY OF A RADIATION DETECTION SYSTEM FOR SPACE TRAVEL. LMSC-703014; Jul 1960. 50p. (Contract AF 29(600)-2049). ASTIA AD-241378.

Preliminary design criteria are presented for a system of instruments for measurement of the species, intensities, and energies of space radiation.

37. Marzano, E. Improvements of the image of artificially radioactive organs by means of a discriminating circuit. NUNTIUS RADIOL. v. 27, p. 296–303. 1961. (In Italian)

A description is presented of a discriminating circuit, which, used in the scanning of a "radioactive picture" produced by body organs containing Au^{198} or I^{131}, considerably eliminates background noise. The principle of the circuit, based on Friedell's circuit is that variations in frequency are transformed into variations in amplitude. A simple diode cut-off system can then be used.

38. Merrill, J. J. and DuMond, J. W. Precision measurement of L x-ray wavelengths and line widths for $74 \leqq z \leqq 95$ and their interpretation in terms of nuclear perturbations. ANN. PHYS. v. 14. p. 166–228. July 1961.

38. (cont'd) Techniques for the precision measurement of x-ray lines using the two-crystal spectometer are discussed, and then applied to measurement of the L x-ray spectra of the transuranic elements uranium, neptunium, plutonium, and americium. In all, 52 emission lines and 4 L_{III} level absorption edges were measured, all of them with higher precision than has heretofore been obtained and many of them for the first time. Using these data, the binding energies of the electrons for these atoms were computed. The L_{II} - L_{III} level splitting was computed and compared with theory and it was found that current theory is not sufficient to account quantitatively for the observed data. Certain features of the emission line widths are discussed and given qualitative explanations in terms of the Coster-Kronig transition L_{II} - $L_{III}M_V$ and hyper-fine structure. The observed hyper-fine structure is due to the large magnetic moment of Np^{237} which leads to increased widths of certain of the Np lines. It is believed that this is the first experimental observation of hyper-fine structure in x-ray spectra.

39. Monahan, J. E. Raboy, S., and Trail, C. C.

Analysis of gamma-ray spectra obtained with an NaI crystal with an anticoincident annulus. In TOTAL ABSORPTION GAMMA-RAY SPECTOMETRY, PROCEEDINGS OF THE SYMPOSIUM. Gatlinburg, Tennessee, 10–11 May 1960. p. 168–87. TID-7594.

A computer program was developed to analyze complex gamma-ray spectra obtained with a scintillation spectrometer with an anticoincident annulus of NaI. The photopeaks are fitted with a least-squares calculation which assumed that the peaks are Gaussian. The contributions from Compton processes and pair production are removed by subtracting the isolated spectrum of each gamma ray, determined separately. The method permits the determination of the width, peak height, and channel position of each photopeak in the spectrum. A "chi-squared" test of the fit to the photopeaks is made. The uncertainties associated with the parameters include statistical uncertainties as well as any uncertainties from the non-Gaussian character of the photopeak. By this procedure the resolution function of the spectrometer and the energies of unknown gamma rays can be obtained in terms of standard lines in the spectrum. Relative intensities of the gamma rays may be obtained by dividing the product of the height and width (the relative area of the photopeak) by the photoefficiency obtained from a Monte Carlo calculation.

40. Murray, K.

Proton-proton spectrometer. REV. SCI. INSTR.

v. 32, p. 347–50. Mar 1961.

A detector system is described which can be used to observe protons in the energy range 2 to 10 Mev, with a discrimination factor against γ-ray background greater than 100 to 1 for γ-ray intensities less than 10^3/sec entering the scintillator. The instrumental linewidth of the detector is about 7% for 5-Mev protons.

41. Owen, R. B.

IMPROVEMENTS IN OR RELATING TO NUCLEAR

PARTICLE DISCRIMINATIONS. British Patent

866,950. 3 May 1961.

A scintillation particle discriminator is described. A dynode of the phototube is operable at a potential difference between it and the next subsequent electrode sufficiently small to produce space-charge limitation of the current leaving the dynode. The discriminator has means for deriving an output pulse from the dynode, and amplitude discriminating means for accepting output pulses above a given amplitude. The dynode described is the last dynode; the next subsequent electrode being the anode.

42. Parkinson, W. C. and Bilaniuk, O. M.

Solid-state detectors for high resolution

nuclear spectroscopy. REV. SCI. INST.

v. 32, n. 10, p. 1136–42. Oct 1961.

43. Philippot, J. C.

Theoretical study of the curves obtained

from a monocanal γ spectrograph. BULL.

INFORM. SCI. ET TECH. n. 45, p. 2–12.

Nov 1960. (In French)

43. (cont'd) A single-channel γ spectrograph that includes a single-channel selector and an integrator was used to plot the spectrum of a γ emitter. A study was made to estimate and correct the systematic deformations introduced into the spectrum by these devices. When the extent of the deformations was determined, it was possible to study two different radioactive elements so that the spectra obtained could be directed compared.

44. Rethmeier, J., Boersma, H. J., and Jonker, C. C.
An improved circuit for pulse shape discrimination between neutrons and gamma rays. NUCLEAR INSTR. & METHODS. v. 10, p. 240–2. Mar 1961.

Electronic devices are described for discriminating between neutrons and γ rays. Neutrons incident upon a stilbene scintillator cause recoil protons, and γ rays cause electron showers; the device is capable of discriminating, by pulse shape methods, between 0.8 to 14 Mev protons (or α particles) and electrons above 200 kev. Pulse height spectra are given, with and without n-γ discrimination, for a combined Co^{60}-Po source, a Hg^{203} source, and a 14-Mev neutron source.

45. Schenider, H.
Radiation meters. VDI ZEITSCHRIFT, v. 103, p. 360–71. 11 Mar 1961. (In German)

Specifications are listed for various commercial radiation instruments, such as activity level indicators, instruments for radiation energy measurements, auxiliary instruments, radiation detectors, monitoring apparatus, and measurement devices for special aims.

46. Schneider, T. and Muenzel, H.
Analysis of simple and complex gamma spectra. ATOMPRAXIS, v. 7, p. 412–19. Nov 1961. (In German)

46. (cont'd) A compilation is given of the most important methods for analyzing scintillation spectra. The quantitative evaluation of pulse spectra with few, widely spaced photo-peaks is discussed. The analysis of complex spectra is described.

47. Sill, C. W.

Determination of excitation spectra with a recording spectrophotometer. ANAL. CHEM. v. 33, p. 1579–84. Oct 1961.

A simple and inexpensive accessory was developed to permit the determination of excitation spectra of fluorescent materials with a recording spectrophotometer. The accessory consists of three front-surfaced mirrors arranged so that the light from the monochromator is redirected to pass through a sample cell at a right angle to the direction taken by the fluorescent light from the cell to the phototube compartment. The signal from the detector reflects the change in intensity of fluorescent light as a function of the wave length of the light incident upon the sample. Resolution and stray light characteristics of the resulting spectra are as good as those of the spectrophotometer used. After correcting for the emission characteristics of the light source, excitation spectra of fluorescent materials parallel closely their absorption spectra and can be used in a similar manner as an analytical tool. However, the excitation spectra may be thousands of times more sensitive and applicable in the presence of other absorbing but nonfluorescent species that would interfere seriously with absorption measurements. Several examples of practical importance are given.

48. Steinhaus, D. W.

Photoelectric comparator for wavelength and intensity measurements of spectra. J. OPT. SOC. AM. v. 49, p. 468–70. May 1959.

A photoelectric comparator is described that can be used for making wavelength measurements, intensity measurements, and observations of the shapes of spectral lines. The instrument is similar to one described by Tomkins and Fred with improvements in the optics.

49. Sweitzer, D.

MEASUREMENT OF GAMMA RADIATION.

Astronautics Information Literature Search

No. 205. 1 Mar 1961. Contract NASw-6.

37p. (JPSLA-LS-205)

An annotated bibliography is presented consisting of 166 references to measurements of gamma radiation found in reports and the open literature through March 1961. An author index is included.

50. Tanenura, T.

Nondispersive x-ray spectroanalysis with

filter and proportional counter. REV. SCI.

INSTR. v. 32, p. 364–6. Mar 1961.

An ingenious pulse analysis method reported by Dolby, Proc. Phys. Soc. 73, 81 (1959), was applied to x-ray fluorescence analysis. Adjacent elements are resolved with an accuracy of several percent. Material with an absorption edge between the characteristic K lines of elements Z and Z + 1 was used as a filter to eliminate the K line of element Z + 1. High intensity and good resolution were obtained with good accuracy and reproducibility, because the results to be obtained are not sensitive to pulse height drift and fluctuations. Two groups of specimens containing two neighboring elements were examined. One group consists of Cu-Zn alloys another mixtures of Al_2O_3 and SiO_2.

51. Vainshtein, E. E.

X-ray spectral analyses (review).

ZHUR. STRUKT. KHIM. v. 1, p. 360–9.

Sep – Oct 1960. (In Russian)

A survey is given of the techniques, equipment, and theory of x-ray spectral analysis. Perspectives, trends, and new methods are discussed. One hundred eleven references.

52. Vertennikov, R. I. et al.

Gamma spectrometer with organic scintillator capable of time resolving selection of radiation. PRIBORY I TEKH. EKSPT. v. 6, n. 2, p. 42–6. Mar – Apr 1961. (In Russian)

Descriptions are given of a γ spectrometer capable of selecting γ quanta with resolving time ~ 1 nsec and operating with plastic scintillators. The resolving time for Cs^{137} γ quanta is ~25%. For the NaI(Tl) crystal the resolving time is ~4 nsec at 90% efficiency counting the Co^{60} γ quantum coincidences.

53. Wagner, E. B. and Hurst, G. S.

A Geiger-mueller γ-ray dosimeter with low neutron sensitivity. HEALTH PHYS., v. 5, p. 20–6. 1961.

It is shown that a commercially available halogen type Geiger-Mueller counter, when properly shielded with Sn and Pb, provides a very practical and satisfactory device for measuring the dose due to γ radiation in the presence of neutrons. The device measures the dose in roentgens with nearly uniform response for effective x-ray energies above about 200 kev and up to at least 1.25 Mev γ energies. Calculations show that the fast neutron response is less than 0.15% and experiments indicate that it is less than 0.5%. Experiments show that about 5×10^9 thermal neutrons per cm^2 give a response equivalent to 1 r of γ radiation. When necessary, the thermal neutron response can be decreased by a factor of 300 by using a Li shield.

54. Wyckoff, J. M.

High-energy x-ray spectrometer using large anticoincidence sodium iodide crystals. In TOTAL ABSORPTION GAMMA-RAY SPECTROMETRY, PROCEEDINGS OF THE SYMPOSIUM. Gatlinburg, Tennessee, 10–11 May 1960. p. 201–10. TID-7594.

54. (cont'd)

A 9-in.-diam. by 6.25-in.-long crystal was used in a total absorption spectrometer for x rays in the 5- to 100 -Mev range. The well-collimated x rays are directed onto the side and along a diameter of the main crystal. On the exit side, a 6.75 by 3.63 in. NaI crystal was set in anticoincidence to detect radiations above 0.6 Mev. The combination of the large crystal and the anticoincidence crystal improved considerably the resolution for high-energy x rays over the resolutions ob tained with various combinations of crystals that were summed to provide a total absorption pulse. The final test of the resolution (and detailed response function shape) will come from the activation curve and (p, γ) data. The initial indications of the improved resolution will be demonstrated by the comparison of the shapes of pulse-height distributions produced by 90-Mev bremsstrahlung spectra transmitted by a 640-cm water attenuator. This spectrum has a characteristic dip at 22 Mev due to giant resonance nuclear absorption which required good resolution for its detailed observation.

55. X-ray spectrometer for satellite. ENGINEER.

v. 28, p. 849. 18 Nov 1960.

A compact, transistorized x-ray spectrometer was developed for use in the "Scout" space research satellite to obtain data for correlation of ionospheric behavior with solar x-radiation. The spectrometer measures the x-ray incidence rate in 5 energy bands within the range 2 to 13 A with a proportional gas counter and transfers the counter data to the telemetry system for transmission or magnetic tape storage. The spectrometer has four 5.5 in.-dia. card modules laminated together and is only 3 in. thick.

56. Yeffseyev, W. S., et al.

Fast-neutron scillation layer-detector for

measurements against γ-ray background.

ACTA PHYS. POLON., v. 19, p. 675–82.

1960. (In English)

A scintillation layer-detector with high detection efficiency for fast neutrons and low efficiency for γ rays is described. The detector is designed for the neutron measurements in the 5 to 20 Mev energy range. Its operation is based on the difference in range between protons and electrons of the same energy.

57. Yokota, R., Nakajima, S. and Sakai, E. High sensitivity silver-activated phosphate glass for the simultaneous measurements of thermal neutrons, γ-and/or β-rays. HEALTH PHYS. v. 5, p. 219-24. Jun 1961.

A new silver-activated phosphate glass which contains a large amount of Li and a small amount of B was prepared. The glass has greater sensitivity for thermal neutrons, is less energy-dependent, and can be prepared to have lower predose reading than the Al, Ba, K, Ag metaphosphate glass. By exposing three pieces of glass covered by brass plate, cadmium plate, and Al foil, respectively, any mixed radiation dose of thermal neutrons, γ rays, and β rays can be measured separately and simultaneously. An integrated dose of 50 mr for γ rays and 8×10^6 n_t/cm^2 can be measured with an accuracy of $\pm 5\%$, and 0.1 r or 1.6×10^7 n_t/cm^2 with an accuracy of $\pm 3\%$.